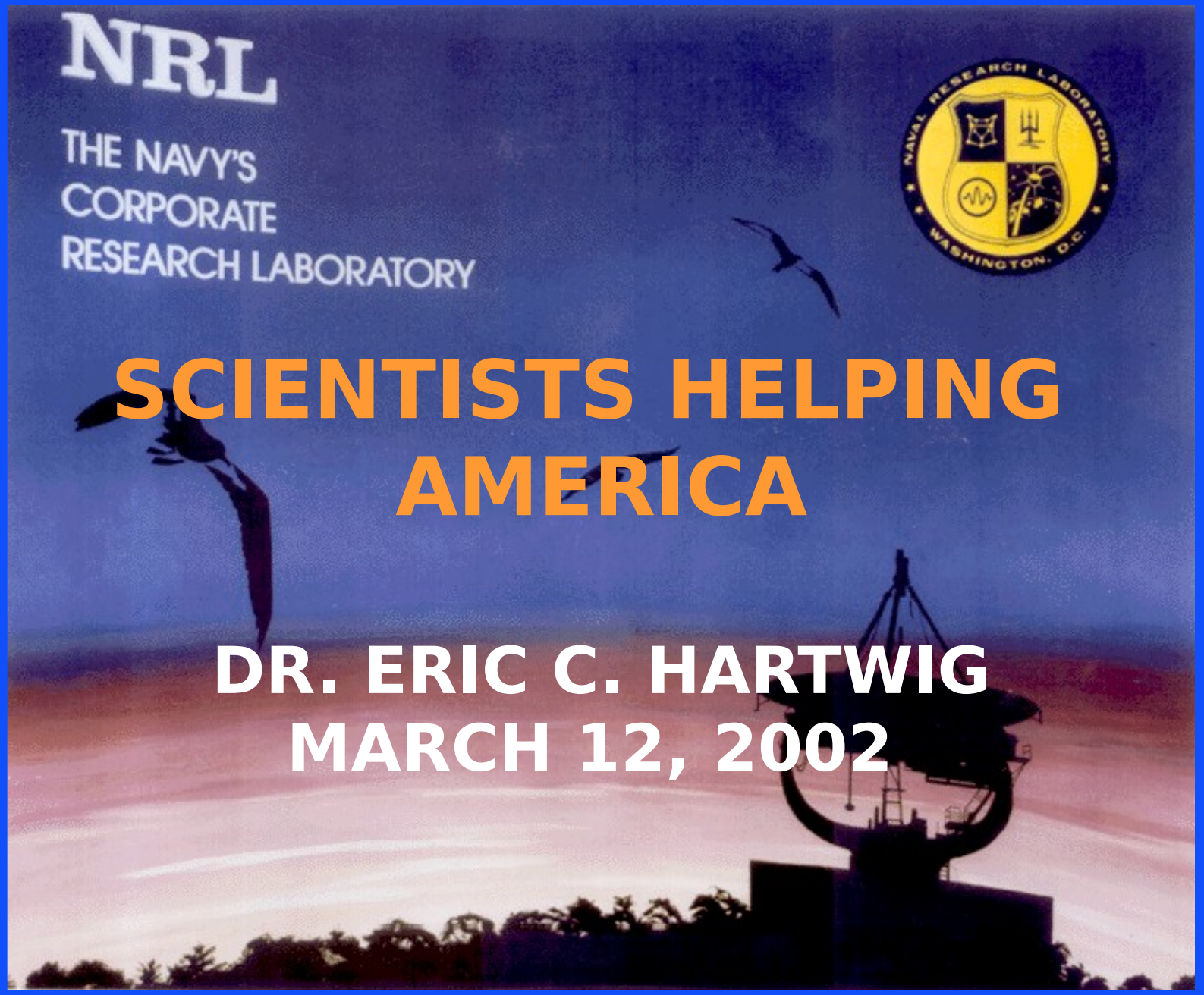
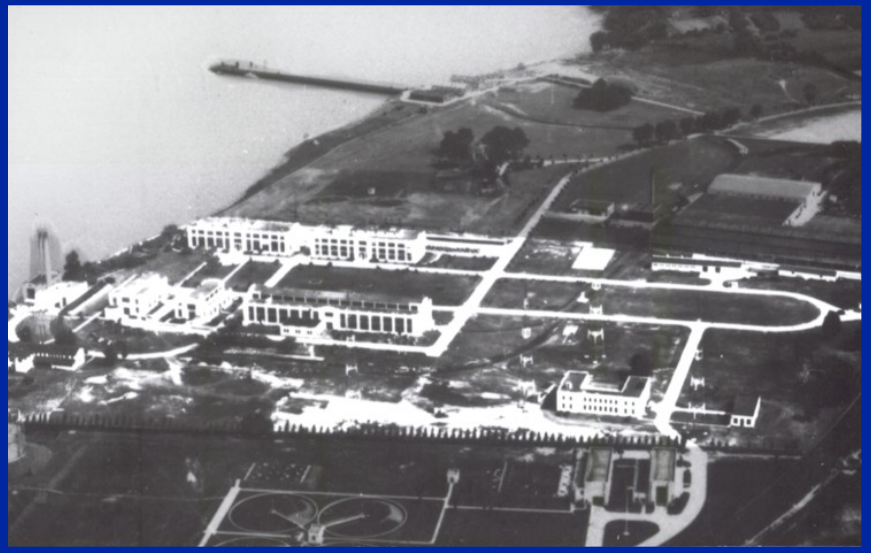


SCIENTISTS HELPING AMERICA

DR. ERIC C. HARTWIG

MARCH 12, 2002

1923



1939

1944

PRESENT

EXAMPLE ACCOMPLISHMENTS

2001 FIRST OPERATIONAL GLOBAL EDDY-RESOLVING OCEAN MODEL

1998

SPECIFIC EMITTER IDENTIFICATION (SEI) AS NATIONAL STANDARD

1994 • DECADAL IMPACT OF EL NIÑO DISCOVERED (1994)

NQR DETECTION OF EXPLOSIVES AND NARCOTICS (1993)

1992 • BOWER AWARD FOR CRYSTALLOGRAPHY

• CLEMENTINE SPACECRAFT (1994)

1990 COLLIER TROPHY FOR GPS

BIO-BASED SENSORS /DESERT STORM (1991)

1989 - FIRST NAVY CRADA SIGNED

1985 • NOBEL PRIZE TO DR. KARLE

• SPACELAB 2

1980

1981 NAVY'S OPERATIONAL GLOBAL ATMOSPHERIC MODEL

HIGH ENERGY MAGNETS (1980)

GPS PROTOTYPE IN ORBIT (1977)

WORLD'S FIRST FIBER OPTIC ACOUSTIC SENSOR (1977)

EXCIMER LASER DISCOVERED (1975)

GaAs STANDARD FOR INDUSTRY (1973)

1970

LUNAR CAMERA (1972)

U.S.S. SCORPION LOCATED (1968)

AFFF DEVELOPED (1966)

U.S.S. THRESHER LOCATED (1964)

1960

PURPLE K POWDER DEVELOPED (1959)

VANGUARD I LAUNCHED (1958)

FIRST U.S. INTELLIGENCE SATELLITE (1960)

1950

SUBMARINE LIFE SUPPORT (1950s - PRESENT)

SYNTHETIC LUBRICANTS FOR JET AIRCRAFT (1950)

PRINCIPLES OF MODERN FRACTURE MECHANICS (1947)

FIRST EXPERIMENT IN SPACE (1946)

1940

FIRST FISSIONABLE U-235 PRODUCED BY LIQUID THERMAL DIFFUSION (1943)

FIRST CONCEPT / PROPOSAL FOR A NUCLEAR SUBMARINE (1939)

FIRST RADAR INSTALLED ON U.S.S. NEW YORK (1939)

1930

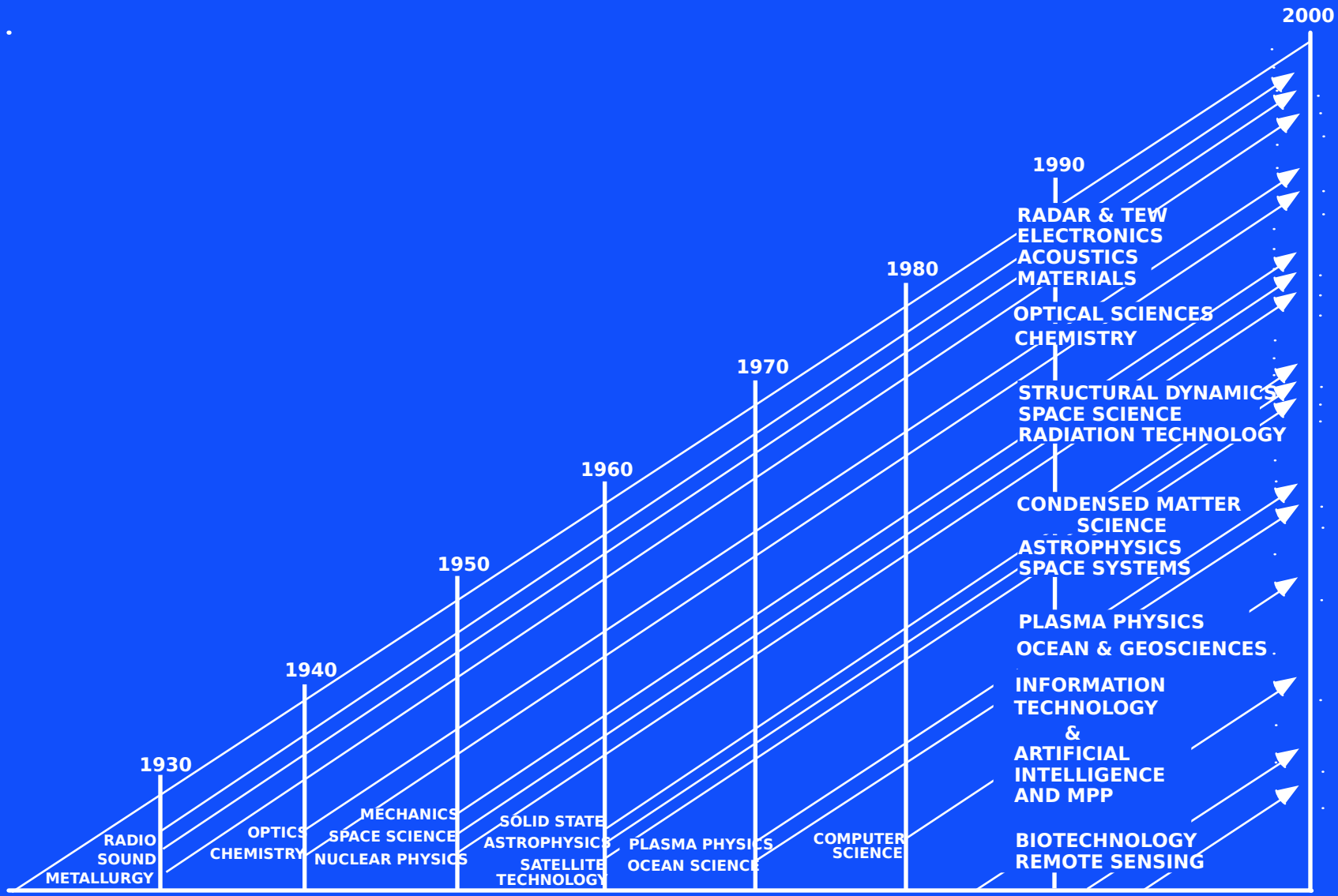
FIRST U.S. RADAR PATENTS (1934)

GAMMA-RAY RADIOGRAPHY DEVELOPED (1920s)

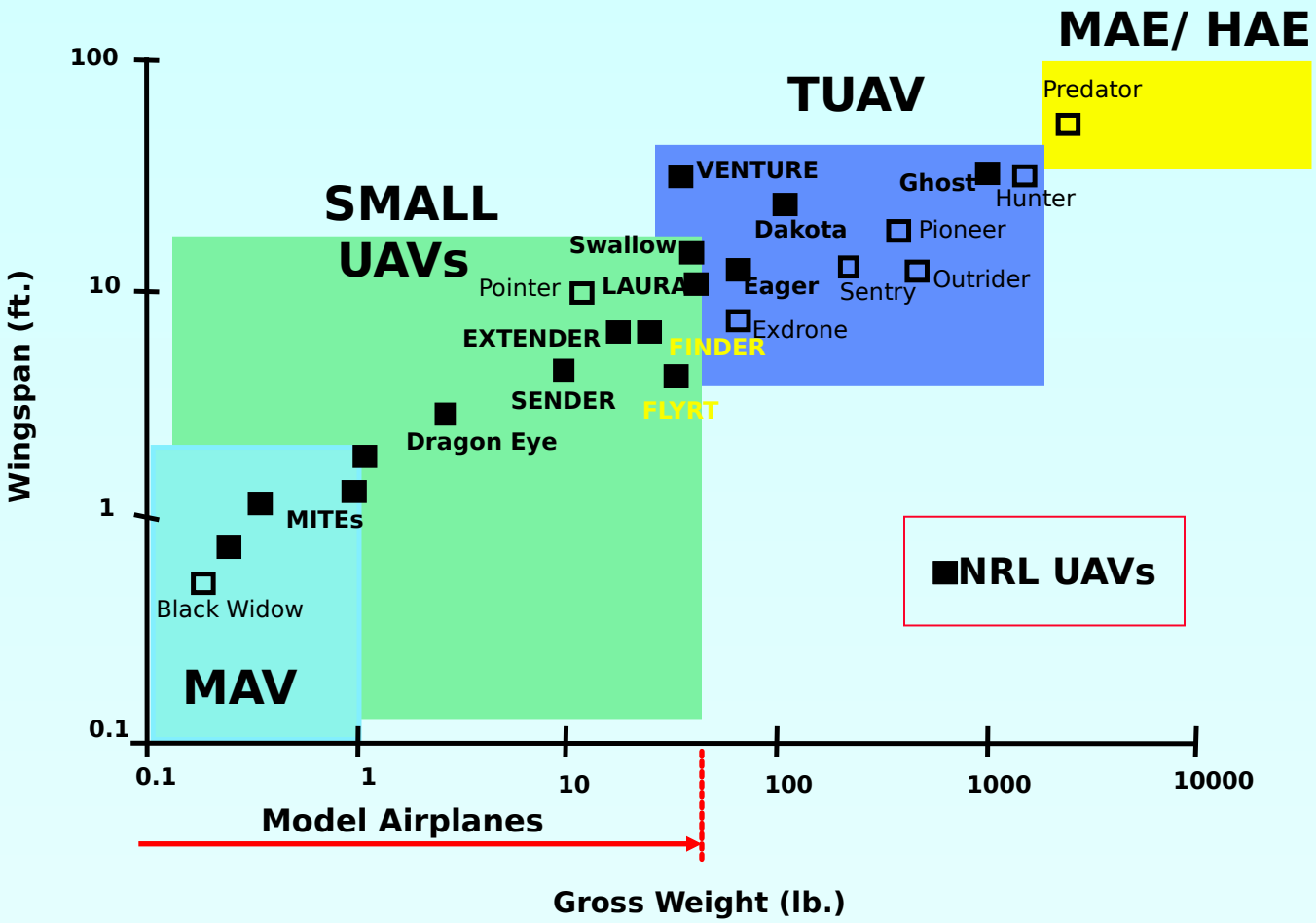
1920

DISCOVERY OF SKIP DISTANCE EFFECT (1924)

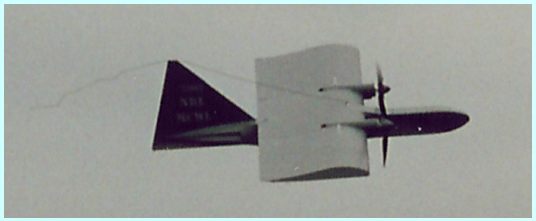
TECHNICAL PROGRAM EVOLUTION



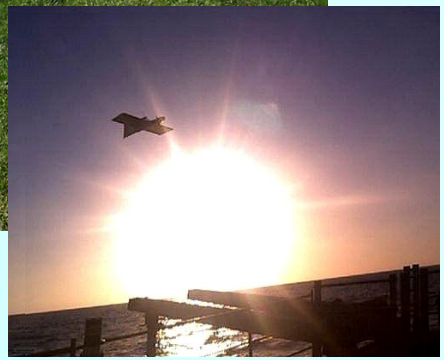
NRL Pioneered the Small UAV and the Requisite Technologies



Dragon Eye & Variants
NRL Man-Portable Small UAV



Dragon Eye
for Over-the-Hill Recce
by USMC Small Units

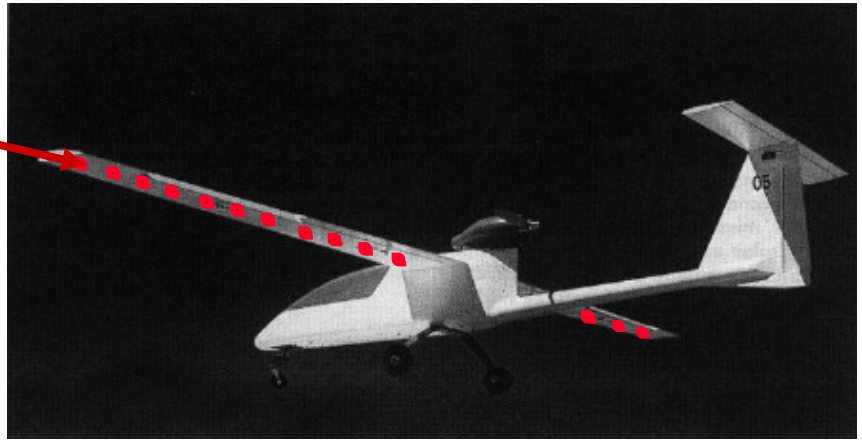


Sea ALL Variant for Maritime Interdiction

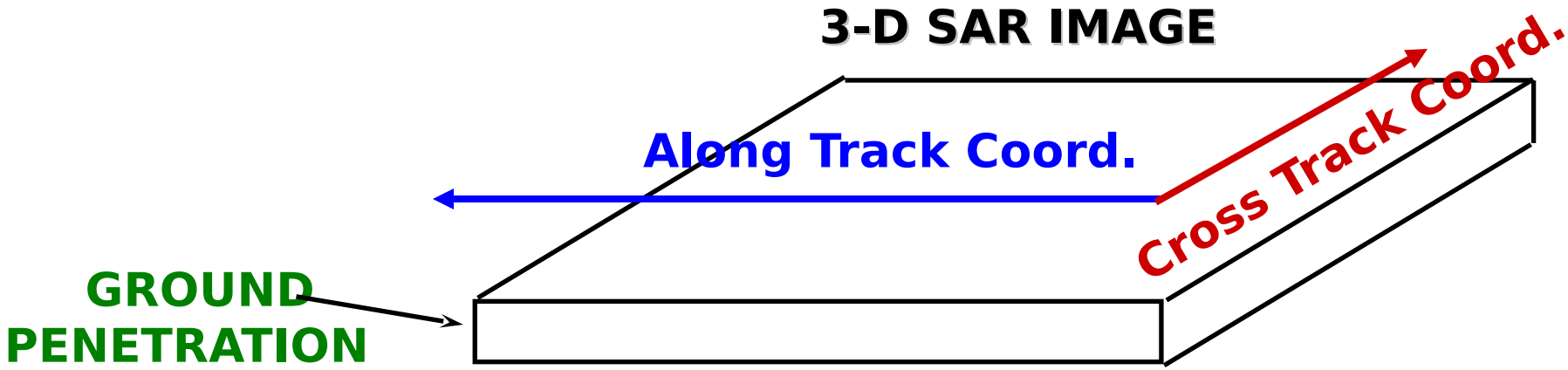
Advanced Tactical Recce (ATR) Varia
for Surveillance and CB Agent Detectio

3-D SAR UAV CONCEPT

- RECEIVE ELEMENTS



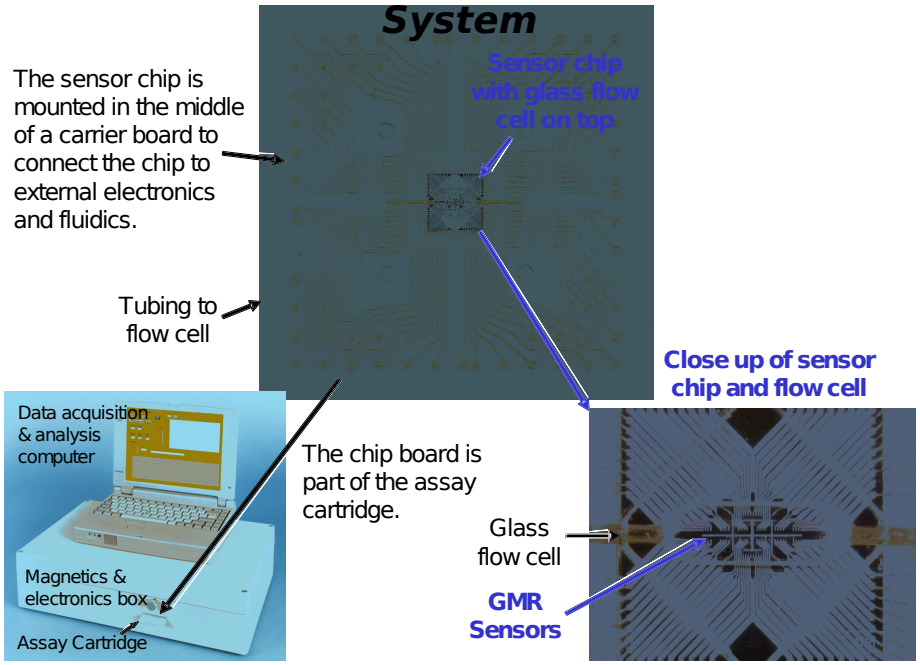
S-BAND RADAR
HEIGHT OF 80 FT
RANGE RESOLUTION 1.5 IN
ALONG TRACK RES. 3.0 IN
CROSS TRACK RES. 3.0 IN



The Bead Array Counter (BARC)

A High-Sensitivity *Optics-free* DNA Chip

Prototype Magnetoelectronic Biosensor System


The sensor chip is mounted in the middle of a carrier board to connect the chip to external electronics and fluidics.
Sensor chip with glass flow cell on top
Tubing to flow cell
Close up of sensor chip and flow cell
Data acquisition & analysis computer
The chip board is part of the assay cartridge.
Glass flow cell
GMR Sensors
Magnetics & electronics box
Assay Cartridge

Concept Description

- Uses DNA-based hybridization assay to detect & identify BW agents
- But uses a magnetic bead to label the hybridization reaction
- Bound magnetic beads detected with embedded magnetic sensor in the chip

Objective

- Develop DNA chip biosensor with enough sensitivity to eliminate need for PCR amplification

Payoff

- Combines state-of-the-art gene chip technology with NRL's MRAM (magnetoresistance memory) program
  - Current BARC sensitivity is ~1800 molecules
  - Current BARC chip has 64-sensing elements for multi-analyte detection

Proposed Next-generation System

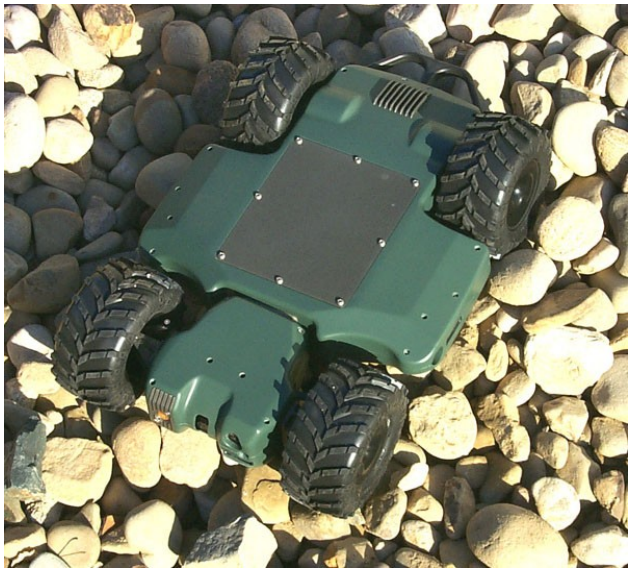
USMC Micro/Mini UGV DRAGON RUNNER

OBJECTIVE

- Provide small & lightweight UGV to the rifleman
- Provide around the corner and down the hall link with video/audio and motion detection
- Provide simple and easy to use wearable control station

APPROACH

- "Less is More"
- Rugged four wheeled vehicle
- Leverage Dragon Eye UAV efforts
- CMU developed vehicle
- NRL developed sensors & WCS



MILESTONES

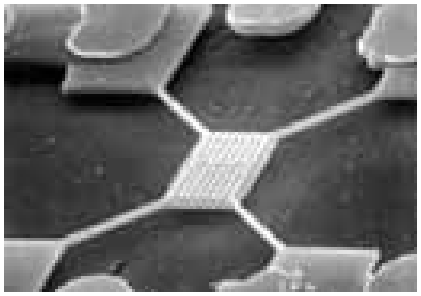
FY01	Vehicle & Sensor design/ prototype implementations
FY02	Final vehicle design / software implementation Deliver 10 vehicles
FY03	60 vehicles & teaming software demonstrations

EUT+: Advanced Wearable Computing

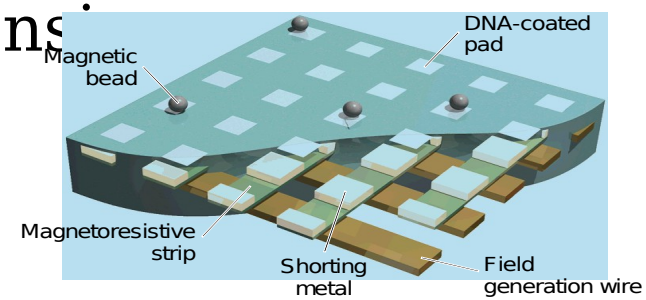
- **Wearable computer used by Marine Corps Warfighting Lab for experiments in Situational Awareness**
- **S&T Research issues include:**
  - **Display technologies**
  - **RF communications**
  - **Low power processor technologies**

UNCLASSIFIED

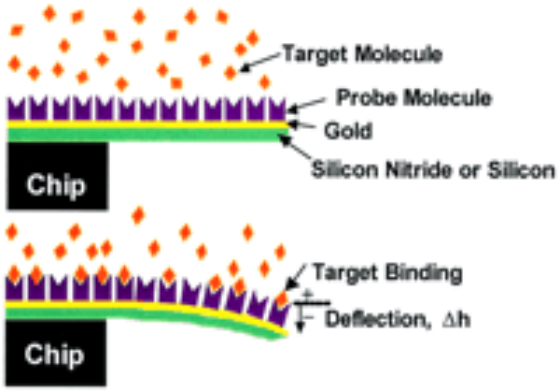
Why Nanostructures for Sens



Nanocalorimeter; Roukes CIT



GMR Biosensor; Whitman/Prinz, NRL



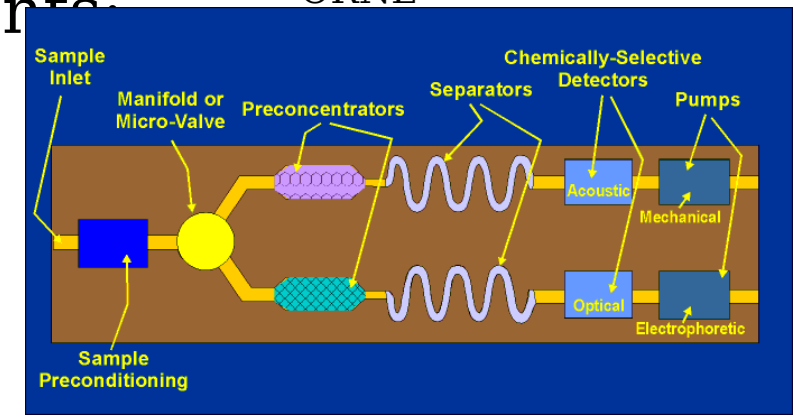
Cantilever Sensor; Thundat ORNL

- Signal to noise improvements:

  yocto(10^{-24})joule,

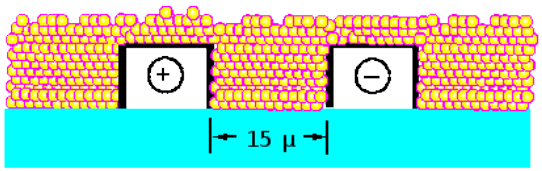
  atto(10^{-18})newton,

  single molecule, ….

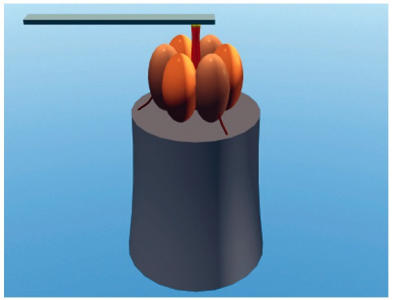


Lab-on-a-chip; Sandia

- Miniaturization – size/weight - arrays
- Lower power, potentially scavenge
- Locally process data into informat



NanoAu Chemiresistor; Snow NRL



Molecular Motor; Montemagno Cornell